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Studying the nucleus via dihadron correlation with an Electron-Ion Collider

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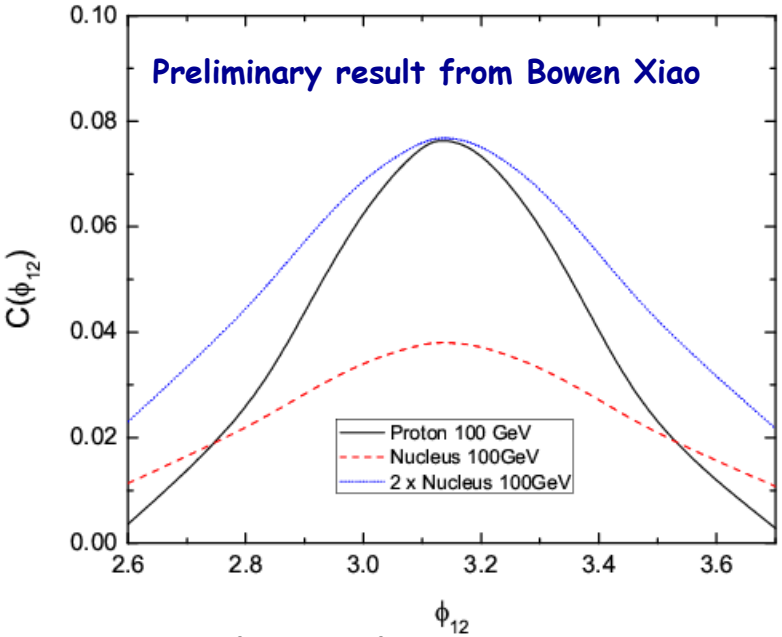
Motivation

- Quantitatively probe the universality of strong color fields in *AA*, *pA* and *eA*.
  - Understand in detail the non-linear regime of strong color fields and the physics of saturation.
  - How do hard probes in *eA* interact with the medium.
- Testing and benchmarking this universality could also help us to constrain and understand results of heavy-ion programs at RHIC and LHC.
- In this talk, I am going to focus on the dihadron correlation, a golden measurement for the *e+A* physics program.

Dihadron Correlation in e+A

Proposed by Fabio Dominguez, Cyrille Marquet, Bowen Xiao and Feng Yuan (arXiv:1108.1713)



$Q^2 = 4GeV^2$, $z_{h1} = z_{h2} = 0.3$

$2GeV < p_{1T} < 3GeV$

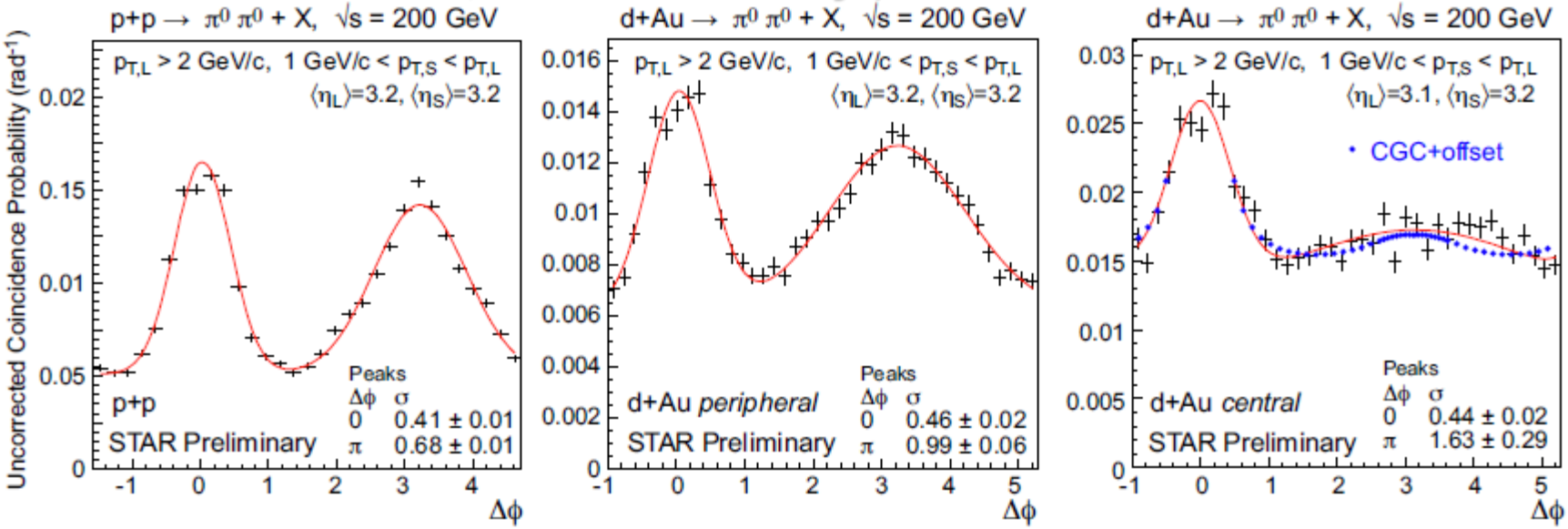
$1GeV < p_{2T} < 2GeV$

- Multi-gluon and single gluon distributions are both important in this case.
- Clean background (no pedestal) and well controlled kinematics (x, Q^2).
- Theory prediction: Notable change between ep and eA collisions, a factor of 2.
- New development of linearly polarized gluon distribution included in this calculation.

Dihadron Correlation in pp and d+Au at RHIC

200 GeV *p+p* and *d* + *Au* Collisions

Run8, STAR Preliminary (arXiv:1008.3989v1)



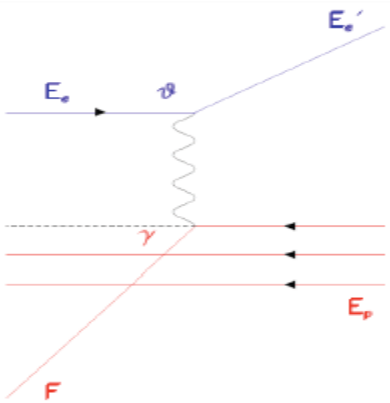
pp ***d+Au (peripheral)*** ***d+Au (central)***

- Tantalizing hints of staurated gluon densities discovered in central dAu of awayside at forward rapidities (y~3.1), agreement with *CGC* prediction
- Probes the region of $x \sim 10^{-3}$
- Subject to many uncertainties (can be constrained by *eA* impact parameter scan and kinematics control)

Dihadron correlation in eA using DPMJet

- DPMJetIII is a multipurpose MC tool unifying all the features of DTUNUC-2, DPMJET-II and PHOJET 1.12 based on the Dual Parton Model.
- Integrated with FLUKA to make nuclear evaporation. Fragmentation treated by JETSET.
- Gribov-Glauber multiple scattering fomalism is used in the simulation of nucleus collision.
- There is no nuclear fragmentation or initial state saturation in the framework of DPMJet.

Dihadron correlation in eA using DPMJet



Event sample:

30+100(GeV) for ep and eA

Kinematics Cut:

$1GeV^2<Q^2<20\ GeV^2$ and $0.05<y<0.95$

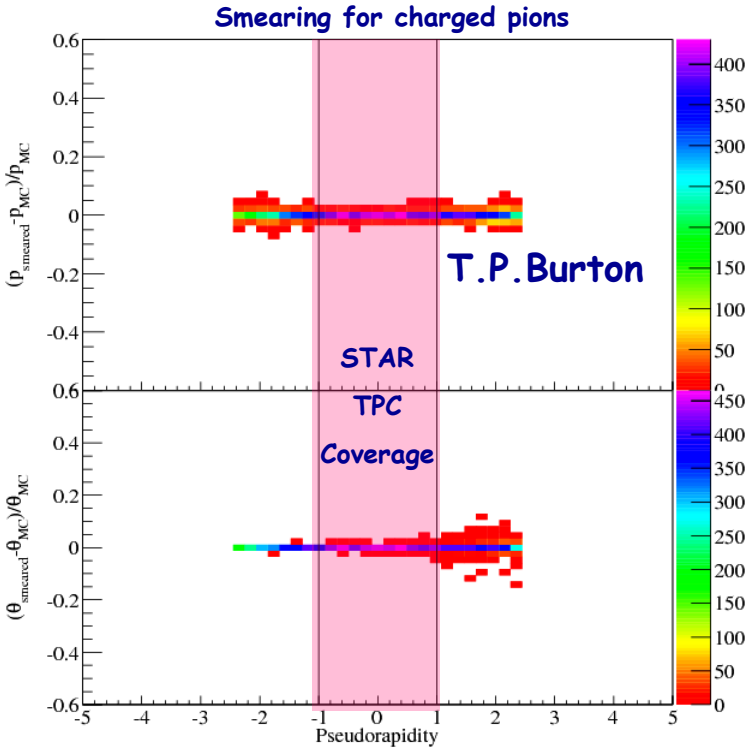
Acceptance and pt Cut:

$10^\circ<\theta_e<177^\circ$

$10^\circ<\theta_h<170^\circ$

$p_T^{trig}>2GeV$

$1GeV<p_T^{asso}<p_T^{trig}$



Fast smearing function:

E: $0.015E+0.14\sqrt{E}$ **P:** $0.005p+0.004p^2$ **θ:** $\sqrt{0.0003^2+(0.009/p)^2/\sin(\theta)}$

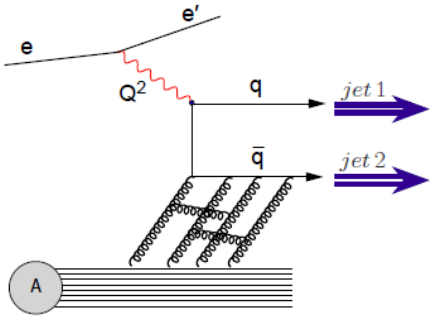
Gaussian distribution with a width mentioned above.

Smearing extrapolation from STAR TPC parameterization

Dihadron correlation in eA using DPMJet

The main channel contributing to our measurement

Boson Gluon Fusion



Analyse Bin:

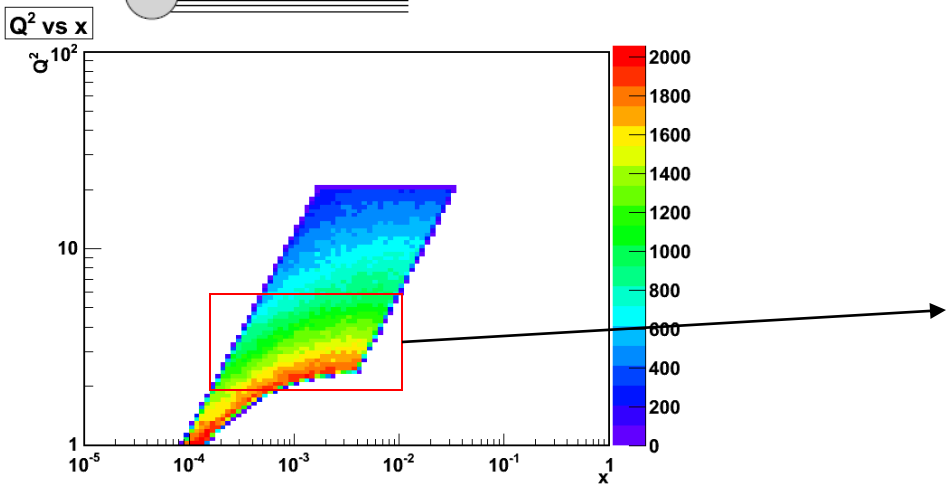
MC without smearing

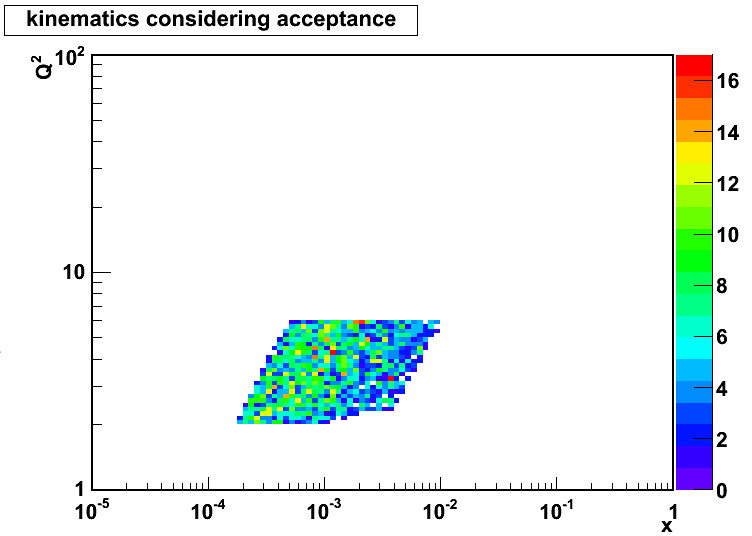
$2<Q^2<6GeV^2$

$0.1<Z_h<0.5$

$z_h = \frac{p \cdot A}{q \cdot A}$, p is the hadron momentum

q for virtual photon, A for coming nucleon

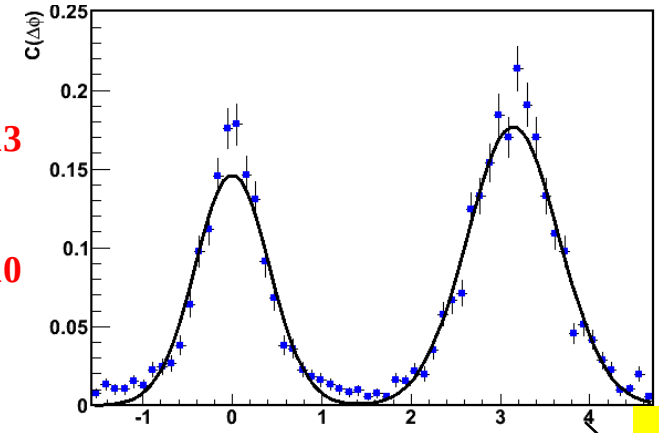


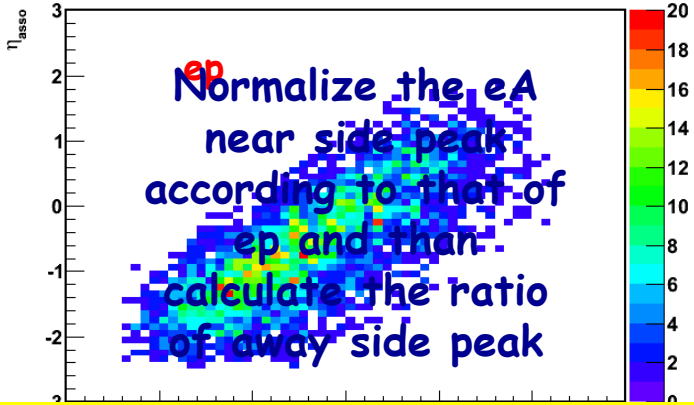


Dihadron correlation in eA using DPMJet

eAu 30+100
Near
σ=0.413±0.013

Away
σ=0.513±0.010





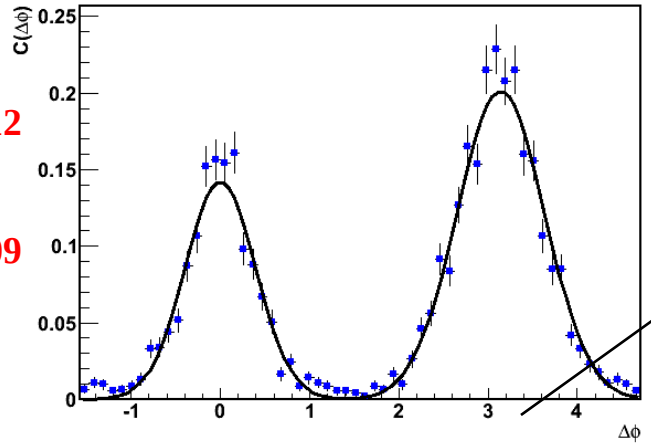
ep

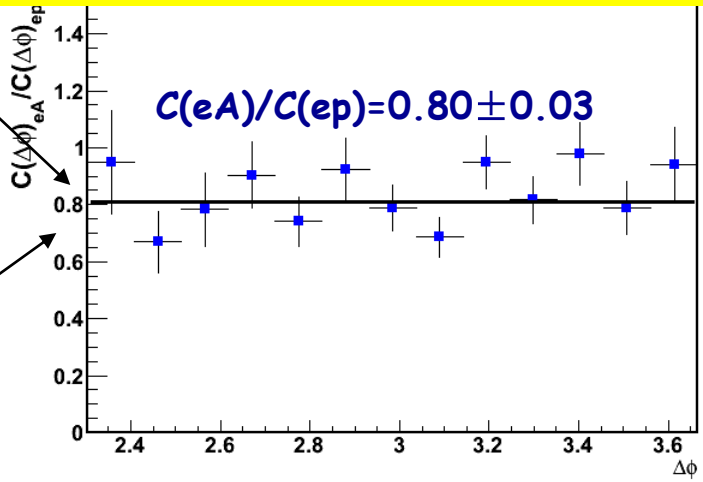
Normalize the eA near side peak according to that of ep and than calculate the ratio of away side peak

DPMJet is not a saturation based model

ep 30+100
Near
σ=0.395±0.012

Away
σ=0.489±0.009



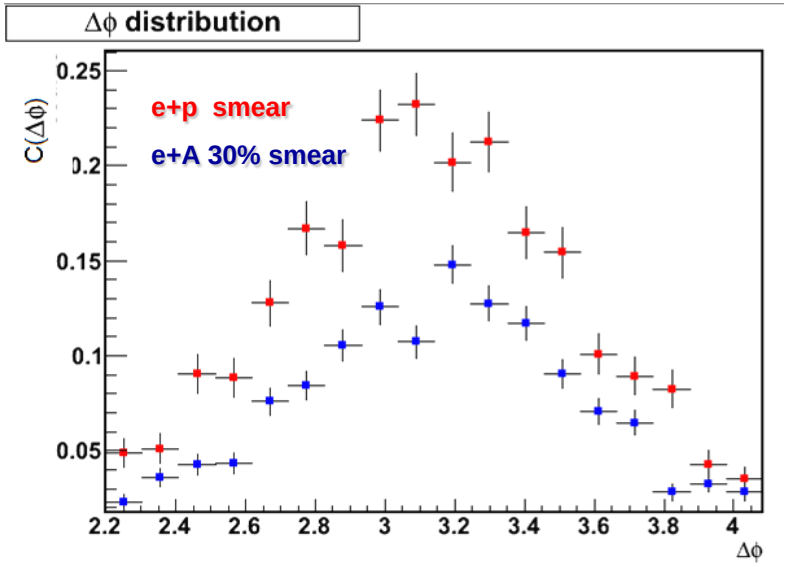


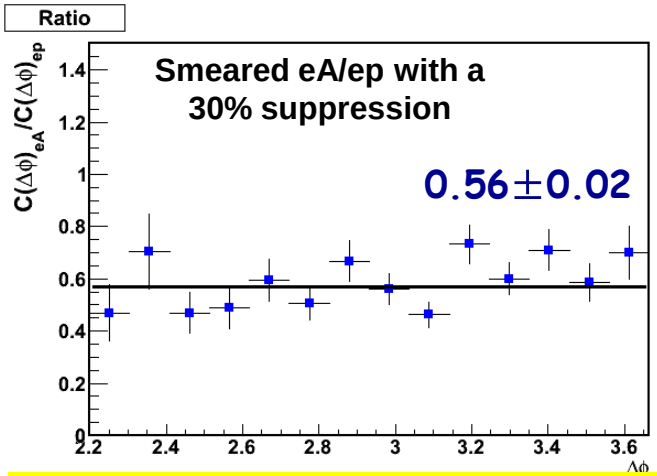
C(eA)/C(ep)=0.80±0.03

Dihadron correlation in eA using DPMJet

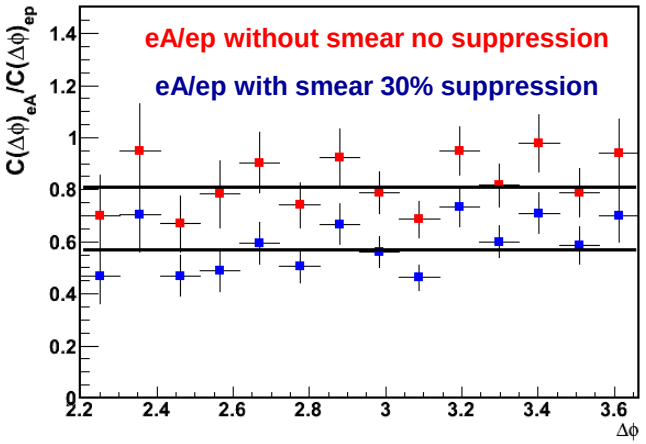
Detector smearing considered, to see the performance of certain detector resolution.

Suppose we have a 30% suppression, can our detector distinguish that?





Smear effect doesn't make a big deal in this measurement!



Conclusion

- e+p/e+A at $\sqrt{s}$ = 100GeV can probe the region lower than x~10^{-3}.
- A notable change from e+p to e+A is predicted by the theoretical model.
- Dihadron correlation is very sensitive to the gluon saturation, thus makes it a golden measurement in eA physics. With a detector smearing parameterization like this $0.005p + 0.004p^2$, $\sqrt{0.0003^2 + (0.009/p)^2/\sin(\theta)}$, $0.015E + 0.14\sqrt{E}$, we can draw a conclusion that the suppression effect in eA can be well constrained by our current level of detector resolution .

Back up

Smearing for electron, mostly out of STAR TPC coverage. Blow up for polar angle out of the coverage.